CLAIMS

What is claimed is:

1. A method for producing a buried tunnel junction in a surface-emitting semi-conductor laser having an active zone with a pn-junction surrounded by a first n-doped semi-conductor layer and at least one p-doped semi-conductor layer and having a tunnel junction on the p-side of the active zone, which borders on a second n-doped semi-conductor layer, comprising:

laterally ablating tunnel junction material, by material-selective etching to a desired diameter of the tunnel junction; and

heating the semi-conductor in a suitable atmosphere until an etched gap formed by the ablating procedure is closed by mass transport from at least one semi-conductor layer bordering the tunnel junction.

2. The method according to claim 1, wherein at least one of the semi-conductor layers bordering the tunnel junction comprises a phosphide compound.

3. The method according to claim 1, wherein the suitable atmosphere comprises a phosphoric atmosphere.

4. The method according to claim 1, wherein heating is in a temperature range of about 500 to 800 °C.

5. The method according to claim 1, further comprising:

starting with an epitaxial initial structure on the surface-emitting semi-conductor laser;

sequencially applying a p-doped semi-conductor layer, the tunnel junction layer and the second n-doped semi-conductor layer on the p-side of the active zone; and

using photolithography and/or etching to form a circular or ellipsoid stamp having flanks enclosing the second n-doped semi-

conductor layer and the tunnel junction layer and extending at least to underneath the tunnel junction layer.

6. The method according to claim 1, further comprising applying an additional semi-conductor layer to the second n-doped semi-conductor layer at the p-side of the active zone, the additional semi-conductor layer bordering a third n-doped semi-conductor layer, wherein the additional semi-conductor layer is laterally ablated to a desired diameter by material-selective etching and subsequently heated in a suitable atmosphere until an etched gap formed by the ablating procedure is closed by mass transport from at least one of the semi-conductor layers bordering the additonal semi-conductor layer.

7. The method according to claim 6, wherein different semi-conductors are used for the additional semi-conductor layer and for the tunnel junction.

8. The method according to claim 7, wherein InGaAsP is used for the additional semi-conductor layer and InGaAs is used for the tunnel junction.

9. The method according to claim 6, wherein the additional semi-conductor layer is arranged in a maximum of a longitudinal electrical field, while the tunnel junction is in a minimum of the longitudinal electrical field.

10. The method according to claim 1, wherein a material-selective etching solution is H_2S0_4:H_20_2:H_2O used in a ratio of 3:1:1 to 3:1:20, if the tunnel junction is comprised of InGaAs, InGaAsP or InGaAlAs.

11. A surface-emitting semi-conductor laser having an active zone with a pn-junction surrounded by a first n-doped semi-conductor layer and at least one p-doped semi-conductor layer, and a tunnel junction on the p-side of the active zone, which borders a second n-doped semi-conductor layer, wherein the tunnel junction is laterally flanked by a zone, which connects the second n-doped semi-conductor layer with one of the p-doped semi-conductor

layers and which is formed from at least one of these adjacent layers by mass transport.

12. The surface-emitting semi-conductor laser according to claim 11, wherein at least one of the semi-conductor layers bordering the tunnel junction comprises a phosphide compound.

13. The surface-emitting semi-conductor laser according to claim 11, wherein the p-doped semi-conductor layer comprises InAlAs which is flanked by a p-doped InP layer and the active zone.

14. The surface-emitting semi-conductor laser according to claim 11, wherein the tunnel junction is arranged in a minimum of a longitudinal electrical field.

15. The surface-emitting semi-conductor laser according to claim 11, wherein an additional n-doped semi-conductor layer is present between the active zone and the first n-doped semi-conductor layer, which is configured as a semi-conductor mirror.

16. The surface-emitting semi-conductor laser according to claim 11, wherein an additional semi-conductor layer is present, which abuts the second n-doped semi-conductor layer bordering the tunnel junction and which itself borders a third n-doped semiconductor layer, whereby this additional semi-conductor layer is laterally surrounded by a zone that connects the second n-doped semi-conductor layer with the third n-doped semi-conductor layer and is generated by mass transport from at least one of these two layers.

17. The surface-emitting semi-conductor laser according to claim 16, wherein the refractive index of the additional semi-conductor layer differs from those of the second n-doped semi-conductor layer and the third n-doped semi-conductor layer.

18. A surface emitting semi-conductor laser according to claim 16, wherein the additional semi-conductor layer is arranged in a maximum of a longitudinal electrical field.

19. The surface emitting semi-conductor laser according to claim 16, wherein the additional semi-conductor layer and the tunnel junction are comprised of different semi-conductor materials.

20. The surface-emitting semi-conductor laser according to claim 19, wherein the additional semi-conductor layer is comprised of InGaAsP and the tunnel junction is comprised of InGaAs.

21. The surface-emitting semi-conductor laser according to claim 16, wherein the diameter of the additional semi-conductor layer is greater than that of the tunnel junction.

22. The surface-emitting semi-conductor laser according to claim 16, wherein the band gap of the additional semi-conductor layer is greater than the band gap of the active zone.

23. The method according to claim 1, wherein at least one of the semi-conductor layers bordering the tunnel junction comprises InP.

24. The method according to claim 1, wherein the suitable atmosphere comprises a mixture of PH_3 and hydrogen.

25. The method according to claim 1, wherein heating is in a temperature range of about 500 to 600 °C.

26. The surface-emitting semi-conductor laser according to claim 11, wherein at least one of the semi-conductor layers bordering the tunnel junction comprises InP.